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AMCOM Hexavalent Chrome Free Initiatives

1 December 2010

SERDP-ESTCP Symposium Washington DC

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
01 DEC 2010		**00-00-2010 to 00-00-2010**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
AMCOM Hexavalent Chrome Free Initiatives	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
U.S. Army Aviation and Missile Command,G-4 Environmental Division, Technology I,Building 111, ATTN: AMSAM-EN,Redstone Arsenal,AL,35898	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

Presented at the 15th Annual Partners in Environmental Technology Technical Symposium & Workshop, 30 Nov ? 2 Dec 2010, Washington, DC. Sponsored by SERDP and ESTCP.

14. ABSTRACT

AMCOM G-4 is currently responsible for Army aviation and missile weapon system environmental life cycle sustainability. G-4 is actively engaged in initiatives to reduce the use of hexavalent chrome used in materials and processes for maintenance of AMCOM aviation assets. Starting in 2003, AMCOM G-4, working with NAVAIR and the Army Research Laboratory, tested a number of coating system combinations to determine if a fully non-hex chrome coating system could provide adequate protection and perform in real world environments. Lab testing was completed in late 2004 and an on-aircraft demonstration started in 2005. Based on test results, Aviation Engineering approved the use of these coatings and beginning in 2006, G-4 has been working with the AVCRADs, ACLC, Depots and other field units to facilitate transition of this technology. Several aircraft have now been painted with the hexavalent chrome free coating system and performance has been excellent. G-4 has used the success of this initiative to expand their efforts to address technologies that eliminate other Cr+6- containing coatings including magnesium pretreatments, missile component coating systems (pretreatments and primers), and other metallic pretreatments. Lastly, G-4 is initiating efforts to evaluate the use of alternative inorganic surface engineering processes such as aluminum anodizing. Funding for all existing test programs is provided by the Army Environmental Quality Technology (EQT), Sustainable Painting Operations for Total Army (SPOTA) Program and the National Defense Center for Energy and Environment (NDCEE) and testing is being conducted at AMRDEC, ARL and CTC.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**22**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

U.S. ARMY AVIATION AND MISSILE LIFE-CYCLE MANAGEMENT COMMAND (AMCOM) HEXAVALENT CHROMIUM IN COATING SYSTEMS REDUCTION

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Overview

- **Background**
- **Aviation Hexavalent Chrome free Conversion Coatings and Epoxy Primers**
- **Missile Weapon System Hexavalent Chrome Free Pretreatments**
- **Tagnite Coated Magnesium Housings**
- **Legacy Coatings Strippers**
- **Future Efforts: Hexavalent Chrome Free Surface Engineering Technologies**

- **AMCOM G-4 is a staff office to the Commander**
  - **Responsible for weapon system and special installation sustainability as it relates to environmental requirements**
  - **Provides environmental oversight and support for all phases of weapon system acquisition**
- **Technology Integration Branch (TIB)**
  - **Address materials and process issues based on Hotline calls from the field/depot**
  - **Develop and coordinate programs for environmentally compliant technologies that support weapon system sustainability**
    - **Partners execute (AMRDEC, ARL, NAVAIR, NDCEE)**

Aviation Hex-Chrome Free Conversion Coatings and Epoxy Primers

- **Test Program initiated by G-4 in 2003 and conducted with NAVAIR and ARL**
  - **Program focus was to assess performance of Cr^{+6}-free coatings as a "system" against standard coating system**
  - **Multiple pretreatments and primer combinations evaluated**
  - **Materials selected for testing based on previous NAVAIR and ARL work (e.g. TCP developed under ESTCP program)**
- **Lab Testing completed in Summer 2004**
  - **Best performing "system" used MIL-DTL-81706 Type II (NAVAIR TCP) and MIL-PRF-85582 Class N under standard CARC coatings (MIL-DTL-64159 Type II, MIL-DTL-53039 1.5 lbs/gal VOC)**

- **Following test data analysis in Fall 2004, on-aircraft testing was scheduled and performed**
  - **First aircraft coated Oct 05 by 1109th Aviation Classification Repair Activity Depot (AVCRAD) in Groton, CT**
    - **Materials and processes validated by 1109th during the DemVal**
  - **Tested coating system on the demo CH-47**
    - **Type II conversion coatings (total aircraft)**
    - **MIL-PRF 85582 Class N primer (lower fuselage)**
    - **MIL-PRF 85582 Class C2 primer (upper fuselage)**
    - **MIL-DTL-64159 Type II CARC top coat (total aircraft)**

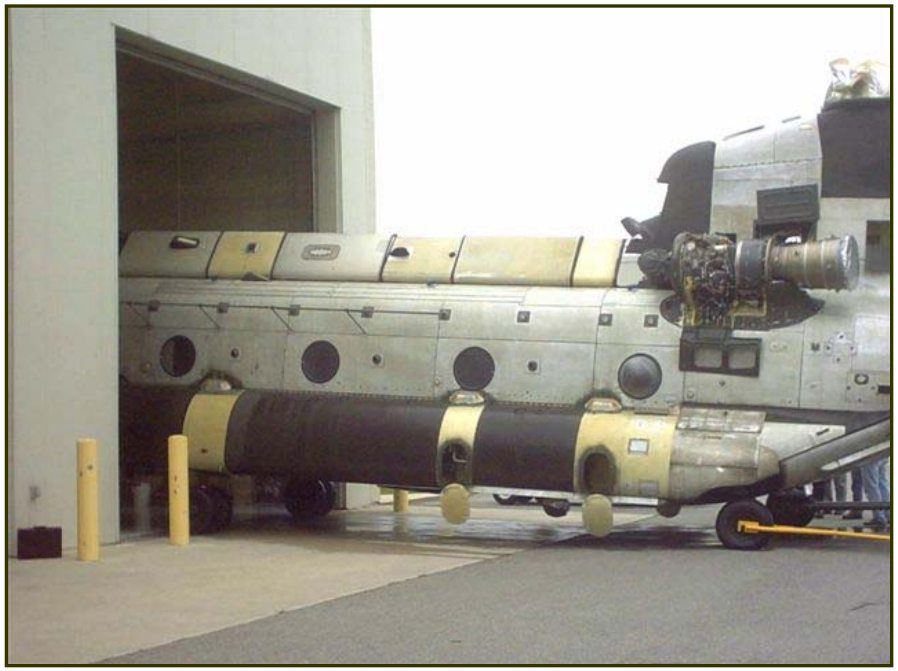
Aviation Hex-Chrome Free Conversion Coatings and Epoxy Primers

- **1109th AVCRAD has continued to apply the Cr^{6+}-free coating system since Jan 06**
  - **Aircraft coated include CH-47, UH-60, OH-58, AH-64, UH-1**
  - **Evaluation of first aircraft coated during periodic inspections shows no difference between the two primers**
  - **No significant difference between the Cr^{6+}-free and standard coating systems on other aircraft inspected**
- **1108th AVCRAD, Gulfport, MS, transitioned to the Class N primers during 2010 and is working towards implementation of the Type II conversion Coatings**

Aviation Hex-Chrome Free Conversion Coatings and Epoxy Primers

Conversion Coating Application

Conversion Coat completed pre-primer application



Aviation Hex-Chrome Free Conversion Coatings and Epoxy Primers

**Aircraft Primed -
Note the two different
primers**

**CARC Top Coat
applied – stencil
application in-progress**

Aviation Hex-Chrome Free Conversion Coatings and Epoxy Primers

- **AMCOM G-4 is now coordinating with Ft. Rucker ACLC and Corpus Christi Army Depot (CCAD) to implement the Cr^{+6}-free coating system at this time**
  - **Class N primers first, then the Type II conversion coating**
- **G-4 is also focusing on 1107th AVCRAD, Springfield, MO and 1106th AVCRAD, Fresno, CA to begin implementation of the new coating system during CY 2011**
- **AMCOM Class N Tiger Team stood up at CCAD to facilitate transition**

- **Test program initiated in summer 2008 and leveraged previous testing performed by NAVAIR, ARL and other organizations**
- **Objective of program is to demonstrate the use of a total Cr^{6+}-free coating system on missile weapon systems/support equipment assemblies (mixed metal) and components:**
  - **Determine if existing missile ground support equipment primers (MIL-DTL-53030/53022) are compatible with TCP pretreatments on aluminum**
  - **Determine performance capabilities of Cr^{6+}-free pretreatments along with ground system primers on mixed metal substrates**
  - **Determine the performance capabilities of aviation MIL-PRF-23377 Class N primers applied over zinc phosphate (ZnP) treated steel substrates**
  - **Determine the performance capabilities of TCP based sealer for zinc phosphate in place of the currently used hexavalent chrome sealer**

- **AMRDEC WDI is testing several different coating system combinations**
  - **Standard accelerated corrosion tests (salt fog, cyclic and SO_2)**
  - **Coating adhesion (wet and dry)**
  - **Weatherability**
  - **Compatibility**

- **Current status**
  - **Wet adhesion testing complete**
  - **Beach and desert testing in work**
  - **Exposure to extreme environments testing in work**
  - **1,600 test panels have been coated with various combinations of pretreatments, primers and topcoats and coded**
    - **B 117 and GMW 14872 testing in progress**

Substrates	Pretreatments	Primers	Topcoats
AA-2024-T3	DOD-P-15328 (Wash Primer)	MIL-DTL-53030	MIL-DTL-53039, Type II, Silica Flattening Agents
AISI 4340	MIL-DTL-81706B, Type I, Class 1a (Alodine)	MIL-DTL-53030, Second Generation "Type II"	MIL-DTL-53039, Type II, Polymeric Flattening Agents
	MIL-DTL-81706B, Type II, Class 1a (TCP)	MIL-DTL-53022 Type I	MIL-DTL-64159, Type II, Polymeric Flattening Agents
	Spectrum Coatings EXGWP-508	MIL-PRF-23377 Type I, Class N (Non Chromate)	
	NAVAIR Chrome Free Process (CFP)	MIL-PRF-23377 Type I, Class C2 (Strontium Chromate)	
	TT -C-490, Type I, Zinc Phosphate with Cr^{6+} Sealer		
	TT -C-490, Type I, Zinc Phosphate with TCP Sealer		
	TT -C-490, Type I, Zinc Phosphate with Henkel Parcolene 99X Sealer		

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Tagnite Coated Magnesium Components

Tagnite Issues

Anodizing cannot be used on mixed-metal assemblies so Tagnite cannot be reapplied to Magnesium housings at CCAD.

Coating Stripping → **NDI** → **Reapply Coatings**

- Can the primer/topcoat be removed and preserve Rockhard?
- Can NDI be performed over Rockhard?
- Is Brush Tagnite or TCP viable candidates for spot repair?
- Can topcoat/primer /Rockhard be removed and preserve the Tagnite?
- Can NDI be performed through Tagnite?
- Are class N primers compatible with Rockhard?

New System

- Topcoat
- Primer
- Rockhard
- Tagnite
- Magnesium

Current System

- Topcoat
- Primer
- Rockhard
- *Dow 7 and 19*
- Magnesium

Cr^{6+}

Tagnite Coated Magnesium Components

- **TAG I**
  - **Demonstration/Validation of Processing Tagnite Coated Magnesium Housings (coatings removal)-NDCEE**
- **TAG 2**
  - **Nondestructive Inspection Testing of Magnesium Transmission Housings for Aviation Systems-AMRDEC and NDI Center of Excellence**
- **TAG 3**
  - **Hexavalent Chrome Free Coating System for Magnesium Housings on Aviation Systems-AMRDEC**

If Tagnite is not preserved during processing, may have to use Dow chromated products for pretreatment

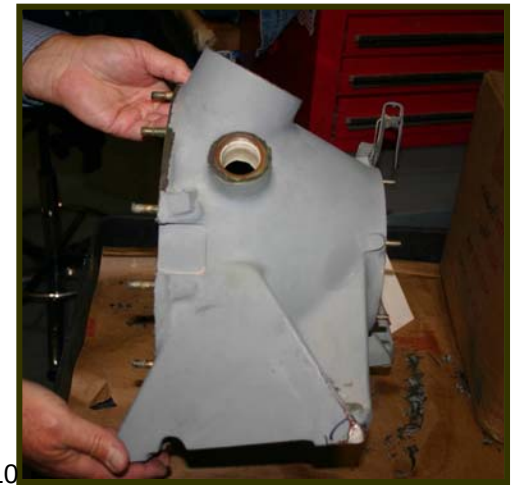
AMCOM G-4 Environmental Division
Demonstration/Validation of Processing Tagnite Coated Magnesium Housings

NDCEE

Objective: Develop process to remove topcoat/primer/rockhard or topcoat/primer (depending on NDI requirements) without damaging underlying coatings

Protocol: Seven commercially available stripping technologies were tested on magnesium coupons in the laboratory

Demonstration: Four commercially available technologies tested on BER housing. Bond Blast, Type I 30/40 proved to be superior for stripping without damage to remaining coatings

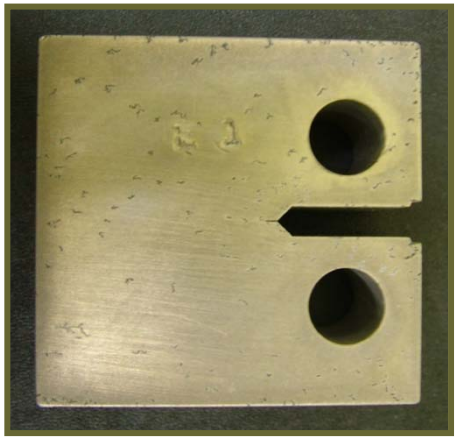


← **UH-60 BER Center Housing. Right - Bond Blast, Type I stripped housing**

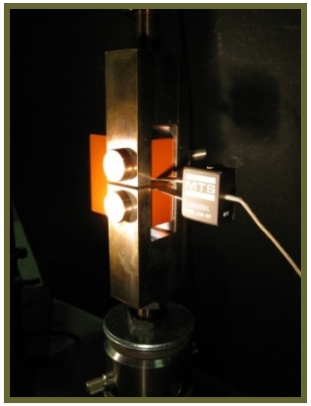
Objective: Develop NDI technique for detecting cracks under Rockhard/Tagnite, Tagnite only and Cr^{6+}-free conversion coatings

Protocol: Develop consistent crack propagation method using fracture toughness coupons and determine if cracks can be detected under Tagnite or Rockhard as well as hex chrome free pretreatments

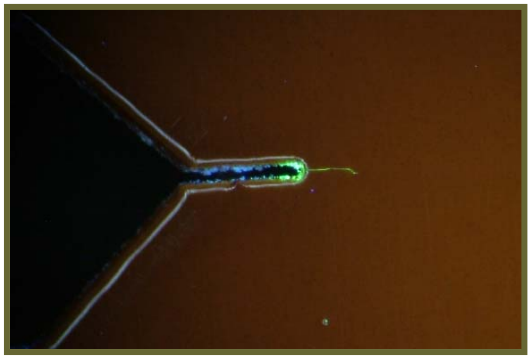
Results: Rockhard appears to be compliant with crack propagation induced in magnesium coupons. Absorption of FPI chemicals and the resulting extreme background fluorescence of Tagnite made crack detection very difficult



Fracture Toughness Coupon



Crack Propagation Method



FPI Tagnite & HT Rockhard 60 X

Objective: Validate Class N primers are compatible with Rockhard coatings and Cr^{6+}-free conversion coating systems can be used as a repair technique

Status:

- **ZE 41A-T5 magnesium coupons have been fabricated and coated with six pretreatments, three resin coatings, two primers and a topcoat.**
- **Wet tape adhesion testing has been completed.**
- **Outdoor Exposure at Beach and Desert Environments is in progress.**
- **Testing of Pull-Off Adhesion, Neutral Salt Fog and Accelerated Corrosion Exposure scheduled for FY11**

Computerized paint equipment at Concurrent Technologies Corporation applying primer to coupons

- **Cr^{6+} solutions are commonly used to strip certain surface treatments during RESET of aviation components**
  - **Removal of aluminum anodizing, chrome plating on aluminum, magnesium surface treatments**
- **Partial funding has been received to generate test plan and baseline performance requirements**
  - **Being executed by the AMRDEC with assistance from G-4 and AED Materials**
- **No existing baseline fatigue, weight loss, Intergranular Attack (IGA) or End Grain Pitting (EGP) data exists for current processes**
  - **This data is critical to the evaluation of alternatives**
  - **Baseline weight loss and IGA/EGP data is currently being generated by the AMRDEC**

Hexavalent Chrome Free Surface Engineering Technologies

- **G-4 is initiating gap analyses to evaluate the following:**
  - **Affected components**
  - **Existing Test Data**
  - **Process limitations**
- **Analyses will form the basis for approval of alternatives or provide detailed test requirements for R&D (EQT TMR)**
- **Currently performing evaluation for chromic acid anodizing alternatives**
  - **Part of Army Toxic Metals Reduction program being submitted to POM FY13-17**

Process	Sub-Process	Specification
Cadmium Plating	Cad Plating Iridite (chromate Conversion Coating)	QQ-P-416F
Brush Plating	Brush Plating	MIL-STD-865
Chrome Plating	Chrome Plating Strip coating on aluminum using Chromic Acid	QQ-C-320
Copper Stripping	Strip coating on steel using Chromic Acid (Note: can sulfuric acid be used in lieu of chromic acid?)	MIL-C-14550
Chemical Conversion Coating	Chemical Conversion Coating	MIL-C-5541
Aluminum Anodizing	Chromic Acid Anodizing Chromic Acid Strip Sodium Dichromate Seal	MIL-A-8625
Anodizing	Type III Dichromate Treatment, DOW 7 Type IV, Galvanic Anodize, Dow 9 Type VI, Chromic Acid Brush-on/Chrome Pickle, Dow 19 Dichromate conversion strip	MIL-M-3171
Phosphate Coatings	Class IV chromic acid rinse	MIL-DTL-16232G
Passivation	Sodium Dichromate Seal	QQ-P-35

Summary of Cr6+-Solutions

- **Successes**
  - **Aviation Cr^{6+}-free coating system for outer mold lines being implemented**
  - **Processing of Tagnite coated housings without removing Tagnite partially demonstrated**
  - **Missile equipment total Cr^{6+}-free coating system being tested**
- **Near Term Efforts (FY11-FY12)**
  - **Continue performing evaluations/gap analyses for replacement of Cr^{6+}-free alternatives in surface finishing technologies**
  - **Continue working implementation of Cr^{6+}-free coating systems at other installations**
  - **Address internal application of Cr^{6+}-free pretreatments for aviation**
  - **Implement processing of Tagnite coated magnesium housings**
- **Long Term Efforts (FY13-17)**
  - **Participate with team members in EQT Toxic Metals Reduction program**

Questions?

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